



## Harmful Algal Blooms and Hypoxia in the Great Lakes Region



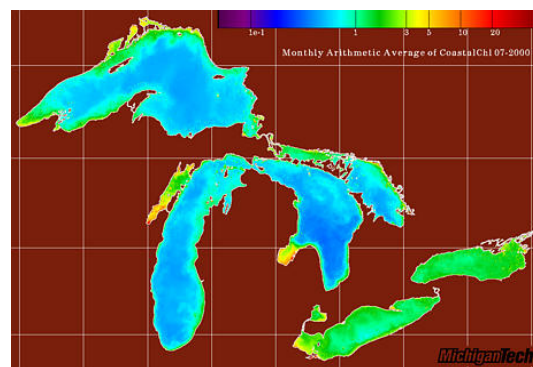
### Introduction

The Laurentian Great Lakes are a major resource to North America, containing 18% of the world's surface freshwater and 90% of the surface freshwater of the U.S. They serve as the focus for a multi-billion dollar tourist and recreation industry, supply 40 million people with drinking water, provide habitat for wildlife and fish, and support transportation and diverse agricultural production. The basin is home to 15% of the U.S. and 60% of the Canadian population. After a period of decline during the 1980s and early 1990s, likely due to the phosphorus abatement programs that limited nutrients and cyanobacteria (blue-green algae) production, harmful algal blooms (HABs) and hypoxia have once again become a very important issue in the lower Great Lakes in recent years, especially western Lake Erie. The cause may be related to the introduction of zebra mussels in the early 1990s which have fundamentally altered energy transfer and nutrient cycling in the lakes and have been identified as the primary cause of the appearance of HABs and increasing hypoxic conditions.

### The Problem

There are several causes of HABs and hypoxia. Some are natural, but others are human-induced, and on-going National Oceanic and Atmospheric Administration (NOAA) sponsored research continues to identify and distinguish these causes. Other types of harmful algal blooms, while non-toxic, reach such large size that the death and subsequent decay of the algae lead to hypoxia in the bottom waters of estuaries and coastal environments.

In the Great Lakes, HABs have been responsible for the closure of beaches, death of wildlife and contamination of drinking water supplies. Intense cyanobacterial blooms have been common in Lake Erie since the establishment of zebra mussels and in the summer of 2004 toxins in the Lake exceeded safe drinking water standards. Harmful algal blooms have also been found in Lakes Ontario, Huron, and Michigan. The cyanobacterium involved, *Microcystis*, has demonstrated the potential to jeopardize human health and drinking water quality.



### Program Description

NOAA is conducting a multidisciplinary and integrated program to study harmful algal blooms and hypoxia in the Great Lakes. Efforts combine monitoring and characterizing *Microcystis* blooms and the ecology and oceanography of HABs in the Great lakes with an understanding of ecological interactions with invasive mussels. Research includes the identification, characterization and inventory of novel freshwater biotoxins, tier-based monitoring for toxic cyanobacteria in the lower Great Lakes, the complex interactions between harmful phytoplankton and zebra mussel grazers and studies to forecast the susceptibility and species changes of the Great Lakes to future increases in nutrient loadings. In Lake Erie, NOAA's Great Lakes Environmental Research Laboratory is participating in a multiagency collaboration, the International Field Years on Lake Erie (IFYLE), to quantify the spatial extent of hypoxia across the lake, gather information that can forecast its timing, duration, and extent and assess the ecological consequences of hypoxia to the Lake Erie food web, including phytoplankton, bacteria, micro- and meso-zooplankton and fish.

#### NOAA HAB and Hypoxia Programs in the Great Lakes Region

- ECOHAB
- MERHAB
- IFYLE
- Marine Biotoxins
- CoastWatch

## Accomplishments

These NOAA activities are helping to evaluate the most cost effective “Alert” protocols to monitor for toxic cyanobacterial blooms; mapping the extent of hypoxia across Lake Erie; providing predictions for the management of nutrient loading to minimize harmful phytoplankton problems in zebra mussel-invaded habitats; increasing general understanding of how nutrients and grazers interact to suppress or promote phytoplankton blooms, and identifying new and potentially dangerous biotoxins in the Great Lakes.



## Looking to the Future

The Great Lakes ecosystem is the most clearly definable regional ecosystem under NOAA’s purview and mission responsibilities, contains a suite of environmental stresses common to all coastal systems, and has a long history of bi-national and interagency partnerships and collaborations. Thus, the Great Lakes have the greatest potential for success in testing regional approaches to addressing the problems of HABs and hypoxia and for the development of ecosystem forecasting tools to predict and help manage these important environmental stressors.

## Current Extramural HAB and Hypoxia Research Projects

- **Ecology and Oceanography of Harmful Algal Blooms (ECOHAB):** *Complex Interactions Between Harmful Phytoplankton and Grazers: Variation in Zebra Mussel Effects Across Nutrient Gradients.* SUNY Buffalo, SUNY Syracuse. Developing management protocols and practices to reduce the effects of increasing cyanobacterial growth in zebra mussels-invaded lakes and to predict how future

invaders (including exotic predators of zebra mussels) and changes in nutrient loading are going to impact harmful phytoplankton in the Great Lakes.

*Investigating chronic toxicity and bioaccumulation of microcystins in freshwater fish using toxicogenomics and histopathology.* University of Tennessee. Investigating the predominant microcystin toxin found in this system (microcystin- LR) in model fish species (zebrafish, channel catfish) and exploring how chronic low-level toxin exposure leads to bioaccumulation in higher trophic level fish in W. Lake Erie.

- **Monitoring and Event Response for Harmful Algal Blooms (MERHAB):** *Tier-Based Monitoring for Toxic Cyanobacteria in the Lower Great Lakes.* State University of New York at Syracuse, SUNY at Brockport, SUNY at Buffalo, University of Tennessee, University of Vermont, Western Michigan University, New York Sea Grant. Developing an integrated alert system to monitor and detect toxic cyanobacteria blooms in the lower Great Lakes (Lake Erie, Lake Ontario) and Lake Champlain.

- **Oceans and Human Health Initiative (OHHI):** *Identification, Characterization and Inventory of Novel Freshwater Biotoxins.* SUNY-Syracuse, University of Tennessee. Determining the identity, distribution and occurrence of toxin-producing organisms and their toxins in Lake Erie.

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